



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

For centuries environment and potential variability were in static balance; variation was zero.

Then came Commodore Perry, humiliations to the inordinate pride of a hermit nation, defeats, contempt, a tremendous response to the changes in stimuli, and to-day dark pagan Japan is easily defeating the largest European Christian white nation: variability unchanged, variation the greatest recorded in human history.

According to Quetelet's celebrated law of variability published some years after Darwin's 'Origin of Species,' it is subject to the law of probability, and according to this law the occurrence of variations, their frequency and their degree of variation can be calculated and predicted in the same way as the chance of death, of murders, of fires.

But such applications did not fit actual evolution, since the law is to deal with different degrees of the same qualities, giving a continuity production of species, while as de Vries has so stressed, the origin may be by abrupt jumps, by sports, by mutations.

De Vries has said that a thorough study of Quetelet's law would no doubt at once have revealed the weak point in Darwin's conception of the process of evolution. It would have shown that the phenomena which are ruled by this law and which are bound to such narrow limits, can not be a basis for the explanation of the origin of species.

It rules the degrees and amounts of qualities, but not the qualities themselves.

Species, however, as de Vries says, are not in the main distinguished from their allies by quantities, nor by degrees; the very qualities differ.

How such differences of qualitative character have been created is the burning question. They have not been explained by

continuous accretion of individual variations.

The attitude of the new mathematics strongly favors attempts like the mutation theory, based on the abrupt, explosive changes, wholly discrete, which under the name of 'sports' had long been observed and known in horticulture and animal breeding, and of which De Vries has found a whole fusilade being shot off by 'Lamarck's evening primrose.'

Here he says there is no gradual, no continuous change or modification, nor even a common change of all the individuals. On the contrary, he says, the main group remains wholly unaffected by the production of new species. After eighteen years it is absolutely the same as at the beginning. It is not changed in the slightest degree. Yet it produces in the same locality, and at the same time, from the same group of plants, a number of new species diverging in different ways.

The vastly vaunted natural selection, then, can only destroy new species, never create them.

GEORGE BRUCE HALSTED.

KENYON COLLEGE,
GAMBIER, OHIO.

*THE ADMISSION OF STUDENTS TO COLLEGE
BY CERTIFICATE.¹*

WHICH is better: the western plan of admitting students to colleges and universities by certificates from duly inspected secondary schools, or the eastern method of admitting only by examinations conducted by representative boards or otherwise?

The question assigned me as a topic is a pressing one at this moment in the history of American education. Within a few years it may be determined which plan,

¹ Paper read before the Department of Higher Education of the N. E. A., Asbury Park, N. J., Friday morning, July 7, 1905.

with all it implies in shaping far-reaching educational ideals and practises, shall be national. The terms 'western' and 'eastern' must not import provincial pride, or sound a note of sectionalism.

As a New Englander somewhat late adopted by the west, may it not be the good fortune of the speaker to lead you all in the discussion to common American ground?

We can adopt the words of Miss Lucy Larcom:

Two worlds I live in—East and West,
I can not tell which world is best;
The friends that people both are dear:
The same glad sun
Shines into each; far blends with near,
And then is now—and there is here—
And both are one.

In truth there is no single 'western' or 'eastern' plan of admitting students to college, though there are dominating practises warranting the use of the terms. Bluntly stated, all the colleges are so anxious to get students that no system is consistently lived up to. They mix the certificate and examination plans, they distribute examinations in time and space, they annex local preparatory schools or have quasi-certified schools of individual tutors and coaches.

From the point of view of the entering student and of the average American, who believes in the widest opportunity for a higher education in a democracy, the existence of twelve gates open day and night in the college Jerusalem may seem desirable. But to the economist and educator the evils of the competition are glaring and threatening, and opposed to this age of the conquests of cooperation and combination.

A glance at the evolution of our methods of admission of students to college will show what evils are imminent, and which is the better plan of admission.

The so-called 'eastern' method of admit-

ting by the examination of the individual student in its earlier form might have been called colonial or English. Originally, each college examined for itself. There was 'personal contact' between the student and examiner. The examination was more or less oral. The appearance and character of the candidate were weighed. With the increase of students and of entrance standards, the substitution of written examinations, first at the college, then at a distance and with the multiplication of studies, the applicants have become not even names, but mere numbers, to be hit at long range by rapid-firing examination-paper guns.

When the colleges began to fire into one another in concentrating their guns upon certain large preparatory schools, and particularly when the big universities brought up their heavy artillery loaded some with ancient and some with modern subjects and methods, the situation became well-nigh intolerable. The secondary school men cried out, and justly 'continually do cry,' and certain great movements were organized. Among the first was the New England Association of Colleges and Preparatory Schools dating from 1885. According to Dr. William C. Collar, of Roxbury, Mass., the association was formed for the purpose of bringing about uniformity in the requirements for college. He believed at the sixteenth annual meeting, in 1901, its work would receive its consummation by providing for admission examinations by a joint examining board as in the middle states and Maryland.² He believed these two boards 'would slay the certificate system and longed to see that done.'³ It was believed that 'the certificate system was making no headway and that the colleges, generally speaking, would be glad to give it up.' On the contrary, apparently

² *School Review*, IX., 619, December, 1901.

³ Page 625.

aroused by the discussion of this very meeting, the friends of the certificate plan formed the next year the New England College Entrance Certificate Board,⁴ now consisting of eleven New England colleges.

Mr. Virgil Prettyman, principal of the Horace Mann High School, is an example of the schoolman's cry for relief. In an article on 'College Entrance Requirements and the High School Program of Studies'⁵ he contrasts with to-day a generation ago, when a boy was admitted to college with a training which would to-day place him not higher than the junior year of high school. The colleges require a training two years in advance of former times.⁶ The increase is in quantity rather than quality. One must know more things. It is a question if he needs to know any one thing better. "The Harvard examinations are arranged in such a way that a boy must keep fresh in at least six studies up to the close of junior year of the preparatory course. Unless a boy passes in at least three subjects (eight credits) no credit whatever is given. It is necessary for the pupils in the last two years of the preparatory course to carry at least six studies abreast. The total result of the present program of studies is haste in preparation, dissipation of energy and interest; physical strain or a tendency to negligence of duties and illiteracy." Mr. Prettyman suggests two remedies (not including the certificate system, in my opinion the cure for his difficulties): "Reduce the number of studies and raise the passing mark or permit the boy to take examinations in three years instead of two, as at present. The necessity for haste and for a cramming process is the greatest burden of the secondary schoolman. Will the

colleges lend a helping hand to the school?"

Another representative secondary school man, Mr. Edward J. Goodwin, of Morris High School of New York City, in an article on 'A Comparison of College Entrance Examinations,'⁷ shows the blight for secondary schools of separate examinations by the individual universities, and indicates what a great want brought forth when it established the college entrance examination board. His study is a comparison of the questions of this board with those of Harvard, Yale, Princeton and Pennsylvania. He rejoices "in the attempt to evolve a scientific method of examination that shall test the instruction and training of candidates for admission to college with substantial accuracy, without cramping the schools, or blighting the enthusiasm of the teachers. That the college entrance examination board has made invaluable contributions toward the accomplishment of this end can not be doubted."

The rise and progress of the college entrance examination board represents doubtless the best that can be done for 'the eastern method of admitting only by examinations,' and meets, where it is accepted, the evils of the conflicting examinations of competing colleges complained of by the secondary school men. Organized⁸ as recently as November 17, 1900, at Columbia, under the inspiration of Nicholas M. Butler, its first secretary, it has grown from eleven colleges and four representatives of the secondary schools in the Association of Colleges and Preparatory Schools in the Middle States and Maryland, to twenty-five colleges and universities and seven representatives of the secondary schools.

It has fulfilled the hope expressed by the editor of the *Educational Review* in 1901, that it would hold annual uniform exam-

⁴ First Annual Report, 1902-1903, Providence, Snow & Farnham, 1904.

⁵ *Educ. Rev.*, 28: 304-305, October, 1904.

⁶ Cf. Professor John H. Wright, of Harvard, *School Review*, V., 700.

⁷ *Educ. Rev.*, 26: 440-456, December, 1903.

⁸ *Educ. Rev.*, 22: 264, October, 1901.

inations in June, for the entire territory north and east of the Ohio and Potomac.⁹ The candidates examined have risen from 973 in 1901 to about 2,100 in 1905. Examinations have just been held at about 160 points in the United States and its dependencies and five points in Europe. A staff of almost 100 readers at the offices in New York City are to pass on more than 20,000 examination papers.¹⁰

In the words of President Butler: "The board has accepted the opportunity that President Eliot pointed out during the discussion which led to its formation of 'making an immense contribution to American education.'"¹¹

In this day of 'cooperative endeavor' it has been whispered, is it possible that the eminent forerunners of the college examination board, the regents of the University of New York, with their tested examination system and its thousands of candidates might join in the combination? Further, there have been movements to make the tests for graduation from secondary schools identical with the tests for admission to college, upon the basis of the college board's examination papers. Mr. Fiske, the present secretary, says 'it is to be devoutly wished.'¹² He declares that the work of the board is now almost ready to pass from a temporary initial state to a permanent condition.¹³

Impressed by its record and that the time of its crystallization is at hand, one can not suppress the query—will the college entrance examination board become national? Will it fasten an examination system upon us? Of course, to do this it would have to change its local complexion

from a little group of twenty-five institutions centering about Columbia. The tendency to a close corporation, since membership is no longer dependent upon meeting an announced standard, but upon election, would have to be reversed.

After the fashion of the Equitable Life, the nature as well as the vastness of the interests would require the mutualization of stock subject to some form of governmental inspection. To cover the national field the present work of the board would have to be so hugely increased that its present work would appear Lilliputian. Taking the figures of the United States census of 1901–2,¹⁴ and the present modes of the board with the desire accomplished that graduation from the school should be dependent upon passing the board's papers, instead of examinations at 160 points they would be at the 8,127 public and private high schools. The present average of 9½ papers for each graduate would require for the 66,262 graduates, the reading of 629,489 papers in place of the present 20,000 and a staff of above 3,000 readers in place of 100, at an expense upon the present estimate of \$5 a candidate or \$331,310, in place of the present \$10,000.

Though the scheme smacks strongly of concentration and the dangers of bureaucracy and lacks a point of national attachment in the bureau of education as at present organized, there is nothing insuperable in it, if the college entrance examination board system is really better than any other.

Before making answer we must review two or three competing plans. First is that of old-fashioned examinations held by individual colleges. In his annual report last week to the Yale Alumni, President Hadley surprised some by saying 'we shall

⁹ *Educ. Rev.*, 22: 531, December, 1901.

¹⁰ Article by Thos. S. Fiske, secretary, in *N. Y. Daily Evening Post*, June 20, 1905.

¹¹ *Educ. Rev.*, 22: 296, October, 1901.

¹² *Educ. Rev.*, 24: 305, October, 1902.

¹³ *Ibid.*, 302, October, 1904.

¹⁴ Annual Rep., 1902, Dept. Interior Com., of Ed., Vol. I., xvii.

probably continue to hold separate examinations instead of joining with other colleges.¹⁵ We may take him as the fairest and ablest protagonist of the old way, while recognizing possibilities of new ways, as is shown by his address on 'The Use and Control of Examinations' before the department of superintendence of the National Educational Association in February, 1901.¹⁶ In brief he says: An examination has two distinct aspects, one looking toward the past, the other toward the future. It is a means of proving a student's past attainment and also of testing his power for that which is to come. A written examination is apt to be a test of the *range* of a student's proficiency rather than of his thoroughness. It loses a major part of its value as a measure of fitness for anything which is to come.

In the passage from the high school to college, the evil is felt most seriously because of the complete separation of control and the remoteness of location, which so often make a system of personal consultation impossible. Here is the most acute controversy. Three methods have been devised to make the range of examination questions wider, to supplement the written examinations by other tests like certified note books, to depend upon certificates given by the teachers of the candidates.

The first method may give too much help to the undeserving student. It offers great opportunities for the coach, for hasty cramming and for the evils of the English civil service and university examinations. The second method of supplementing and correcting the results of examinations by accepting certified note-books, etc., has the merits and defects of a compromise. The frank adoption of a certificate system as a whole would be more logical and better.

The third method, a certificate system, without full discussion of its merits and demerits, has much in its favor. A good preparatory teacher in nine cases out of ten can judge of the fitness of his pupils to enter college better than any college entrance examination board. Each teacher also has a freedom in choice of methods which is of great advantage to him and his pupils.

The first obvious objection is that not on account of dishonesty, but of incompetency, a large number of our secondary school teachers can not be trusted to give certificates. Second, the abandonment of an examination by the college takes away an important stimulus for keeping up the standard of admission requirements. The third objection and the decisive argument for the retention of the old plan is that the colleges which insist on examinations think they get a better class of students by that means than by any other. They get the boys who do not shirk a trial. The fable of the choice of the two doors applies. The first door is labeled 'who chooses me shall get what he deserves,' the second, 'who chooses me must hazard all he has.' The certificate system attracts those who would go to the former door, the examination system those willing to venture the latter.

If each of these alternatives thus proves unsatisfactory, is there not some possible combination which may be suggested? Let us divide our requirements into three groups of subjects:

First, the prerequisites for power to go on with collegiate study, viz., mathematics and the required languages, to prove power of precise thought and of precise expression, where the examinations would be maintained in the hands of the college which is to have the student in charge.

The second group of subjects, viz., the

¹⁵ *N. Y. Daily Times*, June 28, 1905.

¹⁶ *Educ. Rev.*, 21: 286-300, March, 1901.

prescribed readings in English literature, in Latin and modern languages, is considered auxiliary to the attainment of power signified by the first group. President Hadley says: "I should be in favor at once of putting all examinations on the extent of knowledge in these auxiliary subjects into the hands of a common examination board. Whether it would be wise to go a step further and introduce the certificate system in subjects of this group, is a matter which I should hardly like to prejudge at present."

In the third group of studies, history and descriptive sciences, which President Hadley assumes are not a necessary basis for subsequent work, but part of a general scheme of secondary education, recognized by the colleges as a concession to satisfy teachers able to teach them and not to degrade these subjects, the certificate system would be allowed from the very outset.

In wrestling with the objections to his combination and complex, if not compromise, system, he finds relief in extending 'to teachers of proved ability the opportunity to recommend at the risk of their own reputation for provisional admission to our freshman classes pupils to whom the new system seemed to have done injustice.' Thus President Hadley is not far from the kingdom of the outright accrediting system for which we hope he may become a leader, not only amongst his brethren of the eleven colleges in the New England College Entrance Certificate Board, but throughout the nation. The whole thing might be done if Commissioner Draper and President Butler became his coadjutors.

There is time for but a moment's glance at the evolution of 'the western plan of admitting students to colleges and universities by certificates from duly inspected secondary schools.'

It might be called the continental or German plan, whence it in part came to

reinforce preeminently and first in Michigan, a state system of public schools crowned by a state university. It, in some form, logically accompanied a state public school system with a teaching state university, and has been cheerfully adopted, and to their edification, by the private colleges and universities, so that it covers the entire territory from the Ohio to the Pacific and overflows into southern and eastern states.

In its rudimentary form, which the New England College Entrance Certificate Board has adopted, an applying school is placed on an approved list when it can prepare for a college course, and continue to prove its ability to give preparation for college by the record of its students already admitted to college. The admission of the candidate without a collegiate examination in the subjects for which he is certified as prepared by the approved school is probationary.

Naturally, with the increase of schools and students and with a zeal to maintain standards, there followed the visitation of the approved schools by members of the faculty related to preparatory subjects. Thus informally inspection of schools began, until now there are twelve state or state university inspectors in as many great western states, supplemented by visitors from the faculties including great private institutions.

In the North Central Association of Secondary Schools and Colleges, there has been for six years a commission on secondary schools and college entrance requirements, at the heart of which is a board of high school inspectors. Uniform standards and entrance blanks have been prepared. For some time by comity schools accredited by one state university have been accredited by another. But now a list of first-class schools meeting the standards of the commission is becoming an accredited list throughout the entire northwest. In an-

other way has been attained what President Butler said the college entrance examination board stood for: "Uniformity of definition, topic by topic, with a uniform test, uniformly administered. Each college will continue to fix its own standards of admission and to admit its own students."¹⁷

The difference is that the examination or uniform test is of the institution and not of the individual, ridding us of the evils of personal and paper examinations, massed so that all is staked at once for the pupil. President Hadley's allusion to the fable of the two doors is too literally true. Entrance examinations become a gamble and the student seeking to gamble is commended.

A long line of witnesses might be cited from inspectors, college and secondary schoolmen working under the plan of certificates from duly inspected schools, all in favor of the plan.

A few citations pertinent to our discussion will help to answer the question before us.

Leon J. Richardson,¹⁸ of the University of California, shows how the accrediting system has evolved rapidly since 1883 in that state, in harmony with republican institutions. The schools voluntarily established their relations with the university and may sever it at will.

Wm. J. S. Bryan, principal of the normal and high school of St. Louis, says the practise of admitting to the university on certificate only the pupils who have graduated from the approved schools has been a powerful lever in raising the standard of the work done.¹⁹

Edwin G. Dexter,²⁰ professor of educa-

tion, University of Illinois, says: "The east has been attempting the system of admission to college through the certificate system—a modified accrediting system—but they have left out of it the high school visitor, and therein lies the trouble. No inspection on the part of a college professor can ever take the place of the visitation of the inspector, the expert of the secondary school system, the trained friend, adviser and helper and visible connecting link with the university." An advantage of the accrediting system is the increased proportion of high school students who go to college. It is suggestive that in the graduating class of the public high schools in the North Atlantic States, the part of our country little given to the accrediting plan, twenty-six per cent. were for the year 1901 in the college preparatory course. In the same class in the North Central States, where accrediting prevails, the percentage was thirty-four. The accrediting system gives the college students with a better average preparation. The University of Pennsylvania receives about an equal number each year upon each of the two plans—individual examination and certificate. In the fall of 1901, 112 entered by the first method, and 101 by the second. At the end of the semester 49 per cent. of those entering by examination were conditioned as against only 29 per cent. of the certificated students. A suggestive but not a conclusive comparison is of the percentage of failure in first year subjects in one of the Atlantic coast universities, admitting only by examination, and those of five of the larger middle west state universities, where eighty per cent. enter without examination. East, failed algebra, 26 per cent.; trigonometry, 34 per cent. West, failed algebra, 15 per cent.; trigonometry, 11 per cent.

Principal Ramsey, of Fall River, some

¹⁷ *Educ. Rev.*, 22: 291, October, 1901.

¹⁸ *School Review*, 10: 615-619, October, 1902.

¹⁹ *Proc. 5th Annual Meeting N. C. A. S. S. and C.*, 11, 1900.

²⁰ *Nat. Conference Secondary Ed.*, N. W. University, p. 94, October, 1903.

years ago in a study to determine the relative merits of the two methods of college entrance, received answers from college officers in favor of certificated students: In mental ability, five to one; in the general performance of college duties, three to one.

Professor Whitney, of Michigan, investigating the freshman grades of more than 1,000 students, about equally divided between those entering upon credit and those taking entrance examination, found that the average standing of the former was more than one and one half per cent. higher than for the latter.

Impartial testimony might be gleaned from European educators. Professor T. Gregory Foster in the report of the last Alfred Mosely Commission²¹ rejoices that it is a fundamental principle in American universities, that the man who is fit to teach is also to be trusted to examine his own students. He remarks: 'As long as examinations control the teaching, whether in universities or schools in this country [Great Britain], so long will the teaching continue to be academic in the worst sense of the word, cribbed, cabined and confined.' He notes the degree to which examinations by external bodies or examiners is regarded as baneful in the United States both to the pupil and for the educational organization, and commends the attempt of the college entrance examination board to guard against some of the evils by having secondary schoolmen on the board. But to Professor Foster the accrediting system of the middle west is 'a more significant plan' and one rapidly spreading into the east. He says: "In the states where it has been adopted, the whole educational system has been unified and strengthened. The barriers between various grades of teachers are being removed. The teaching of all classes

of teachers is thereby made more direct, more stimulating and attractive to students. The accrediting system as *versus* the older leaves the teacher and the taught free and thereby stimulates to better training.'" Professor Foster quotes President Harper as opposed to the accrediting system when he left Yale, but now as a firm believer in it as a result of his experience. The professor concludes: 'It is perhaps one of the most noteworthy contributions of America to educational progress.'

Mr. M. E. Sadler,²² director of special inquiries and reports, Educational Department of England and Wales, speaks decisively as to certain principles applicable to our discussion:

"State certificates bestowed as results of written examinations at a prescribed moment at the close of their school life, are injurious in their influence as well on the work of the schools as on the physical, mental and ethical development of the pupils and also on the national ideals of education, and on the parents' conception of what education can do and ought to do. The more valuable influences of a secondary school lie in its tone, its *idiosyncrasies*, in its tradition, in the outlook which it encourages its pupils to take on life and duty, in the relation between teachers and scholars, in the relation among the scholars themselves. None of these things can be tested by written examinations, conducted by examiners, however able or impartial, who have never seen the school. It is judged on *paper*. It is possible for a school to simulate great intellectual efficiency by reason of an intensive process of 'cram' which reflects immense credit on the skill and industry of the teachers, but guarantees little of permanent educational value to the pupils prepared. Yet a system of merely written

²¹ Pp. 115-118.

²² *Educ. Rev.*, 21: 497-515, May, 1901; cf. pp. 507-12.

examinations conducted by examiners at a distance fails and must necessarily fail to discriminate between two effects superficially and temporarily similar, but really and permanently different."

He adds: 'The natural antithesis to written examinations is a system of inspection.' He weighs the difficulties of inspection in a national provision for secondary education, and would find a formula for some form of consultative committee with the state—'neither to have too much state nor too little state.' "*Laissez-faire* is impossible in this period of rapid transition."

This last is true in America. What we do we must do quickly. A national system, meaning thereby governmental coordination and possible inspection in harmony with the voluntary cooperation of private institutions, like the accrediting systems now prevailing in many western states, concatenating secondary schools, colleges and universities, will give modern interstate educational privileges, long needed to keep up with interstate commerce and life and heightening national ideals and power.

The line of evolution is clear. The oral examination of the individual pupil by the separate college, the written examination in the same fashion, the combination of colleges for written examinations, the slight recognition of the preparatory teacher in the combination, the great recognition of the preparatory teacher and his examinations by the certificate plan, and the highest point of evolution, the examination by the combined colleges of the secondary school as a whole, and the accrediting of it organically, trusting it all in all or not at all.

The disappointed hearer who looked for a formal disputation in this paper may be still demanding a categorical answer to the question of our topic 'Which is better, etc.?'

Let him draw his own conclusions from

the testimony marshalled from the best representatives of the different systems.

As an evolutionist I see every system has a part to perform, and perceive certain principles at work which promise us not only a better system, but a national and best.

GEORGE E. MACLEAN.

UNIVERSITY OF IOWA.

SCIENTIFIC BOOKS.

Text-book of General Physics for High Schools and Colleges. By JOSEPH S. AMES, Ph.D., professor of physics and director of the physical laboratory in the Johns Hopkins University. New York, American Book Company. 1904. Pp. 768.

About eight years ago Professor Ames published his 'Theory of Physics' and established his reputation as a skillful writer of text-books. The present volume was initially undertaken as a revision of the former one, but the author soon found that it was more convenient to prepare a new book independently, with occasional inclusion of matter that had been previously put into such good form as to require but little modification. He believes now, as then, that to present the subject of physics to a class of students three things are necessary: a good text-book; experimental demonstrations and lectures, accompanied by recitations; and a series of laboratory exercises. This book is intended to state 'the theory of the subject in a clear and logical manner so that recitations can be held on it.'

The class-room presentation of any subject that requires frequent experimental illustration necessitates the abandonment of the text-book by the teacher while engaged in the work of exposition. The text-book becomes the basis for parallel study on the part of the auditor, and recitation days are most conveniently differentiated from exposition days. Presumably the present volume is the writing out of at least the greater part of the lectures given at Johns Hopkins University to the students of general physics, who are assumed not to possess at the outset any knowledge of advanced mathematics. It was probably for